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Abstract

Development of the Superheat Reactor in the Federal Republic of Germany

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The development of the boiling water reactor to a reactor with nuclear superheating of steam represents one of the most interesting improvements of today's power reactors in technical and economical respect. A number of various concepts has been proposed for this purpose. Since 1960 AEG in the Federal Republic of Germany is working on the development of an integrated single-zone superheat reactor with combined boiling and superheating elements. The decisive advantages of this concept are represented by excellent shut-down and emergency cooling characteristics, elimination of additional structure material in the core, uniform core design, fixed correlation of superheat and boiling power independent from control rod positioning and nearly independent from power, low maximum fuel temperatures, low reactivity flooding coefficient and relatively low steam content on the boiling side, favorable for the future development to higher outputs per liter. Hereby a relatively complicated steam rooting and the occurrence of considerably different thermal expansions in the element have to be overcome.

Since 1960 the developmental work has resulted in the design of a prototype power station with 100 MWth. The power station is to be erected in the direct vicinity of the boiling water reactor Kahl. The following problems of the development program have been treated:

Development of Fuel Elements - Theoretical Work

Theoretical study of element behaviour, design of models and com-

pilation of computer codes.

Fabrication of Fuel Elements

Experimental fabrication of superheat fuel elements, development work with the aim to master vibration and swaging techniques for cladding materials, concentric vibration of cladding tubes, making of weld joints with different superheat cladding materials and different types of weld seams.

Testing of Fuel Elements

Testing of combined boiling and superheat elements under full operation-temperatures of the cladding and under the full steam pressure, thermocycling tests with the fuel elements, creep tests with cladding materials under full temperature conditions, creep tests with irradiated cladding materials for superheat elements at full operating temperature during irradiation as well as during the creep testing, operation of the first combined boiling-superheat elements in the Kahl Experimental Loop since December 10, 1963.

Corrosion Tests

Corrosion studies in autoclaves under temperatures of up to 700°C, influence of oxygen and chlorine content on stress corrosion cracking, experiments in test solutions, results of experiments with special melts particularly for use in superheat reactors.

Reactor Physics Work

Elaboration of calculating methods and computer codes for superheat reactor lattices, evaluation of superheat reactor lattices in the AEG Test Reactor in particular in view of the flooding reactivity coefficient, measuring and calculation of the thermal utilization factor in the large Seitz-Wigner-Cells of the superheat reactor.

Thermodynamic Work

Theoretical studies, elaboration of computer codes, measuring of burnout, steam slip, steam distribution and pressure drop of steam-water mixtures in the test rig under full pressure and temperature conditions, theoretical and experimental study of steam-water separation.